Market demand for smaller widebody freighters is strong, and is the fastest growth sector of all cargo aircraft. The 767-300ER is the popular airliner for passenger-to-freighter conversions. This is likely to change when A330-300 market values have declined to sufficiently low levels.

Picking 767-300ERs & A330s for freight conversion

The number of annual 767-300ER passenger to freighter (P-to-F) conversions has increased by 42% over the past three years. Urgent acquisition of retiring 767-300ER passenger fleets by lessors and freight carriers for P-to-F conversions further highlights the high growth rates in its size sector. It is predicted that up to 1,300 freighters in the 767-300ER's size bracket will be needed over the next 20 years to meet demand. The better passenger-configured aircraft as potential candidates for freighter conversion are examined here.

The medium-size freighter fleet of aircraft with a 30-80 ton gross payload has been increasing by 35-62 aircraft per year over the past three years *(see table, page 56)* for two reasons: to replace older aircraft with poor performance; and to meet increasing demand for air cargo by e-commerce.

New fuel-efficient A350s and 787s are quickly replacing older aircraft such as the A330 and the 767 in mainline passenger fleets. Market values of used types fall once airlines have retired a large block of aircraft, and this is to a level that makes them ideal to be converted to a freighter.

The 737-300ER makes an excellent medium-size freighter for the express freight market, because of its affordability, payload characteristics and suitability for domestic and international flight operations.

P-to-F conversions for the 767-300ER are offered by Boeing and Bedek, a division of Israel Aerospace Industries (IAI). Boeing sells a new factory-built option, the 767-300F, at a list price of $220.3 million. This aircraft is based on the 767-300 series, and has a gross payload of 127,868lbs/57 tons. The 767-300F is popular with tier-one integrators, UPS and Fedex. Few other airlines have acquired it.

Until recently there has not been an A330 P-to-F conversion programme. In 2018 Elbe Flugzeugwerke (EFW) converted two A330-200 and two A330-300 aircraft. They have a gross payload of 132,300-134,500lbs/59-60 tons *(see table, page 56)* that makes EFW's converted A330-200s and -300s viable alternatives to converted 767-300ERs.

Conversion economics

For an aircraft to be suitable for conversion, its age, accummulated flight hours (FH) and flight cycles (FC), and maintenance condition must align with a low enough market value.

Total cost of preparing a freighter for service will include the two largest elements of acquisition cost of the feedstock aircraft and the cost of conversion. There will also be some maintenance to perform.

It is important to maintain a balance between an aircraft's low purchase price and it remaining useful service life. There are fewer passenger-configured 767-300ERs to choose from for conversion.

"We will run into a situation where the 767 will be old, and there will be plenty of A330s fresh from passenger fleets available for conversion," says Stephen Fortune, principal at Fortune Aviation Services.

According to Fortune, values for a late 1990s 767 with engines that have three or four years life remaining cost about $12 million. "It is hard to see that number getting much lower, partly because most of the value is in the engines."

Therefore, a freighter conversion makes sense when the value of the airframe gets close to part-out value. A part-out will depend on how much time is left on the engines. A pair of engines with a good half-life will be worth about $9 million. .

"Feedstock prices for A330-300s now are a little high," says Fortune. "They are still well in the $20-30 million bracket. For a conversion to make sense the price needs to be below this. Owing to the poor performance of early A330-300s with low maximum take-off weights (MTOW), buyers will have to look past a 1998 aircraft. This costs $10-11 million more than a 767, and you cannot justify that premium."

It is forecast that A330 -300 feedstock values could be at the correct price-point for conversion in the next three years.

IAI

Bedek introduced the supplemental type certificate (STC) for the 767-300ER P-to-F in 2009. From 2009 to 2018, Bedek converted 63 aircraft *(see table, page 56)*, equal to 65% of the total number of 767-300ERs converted.

Conversion costs are $13-15 million; list prices will depend on the quantity of aircraft converted. Converting a 767-300ER costing $12 million, with a reasonable maintenance status, adds up to a total on-ramp cost of $27-28 million, with some more for maintenance.

BDSF is the suffix for aircraft modified with a Bedek P-to-F conversion. According to IAI's aviation group marketing vice president, Rafi Matalon: "IAI has seven 767 conversion lines in Israel, and one line in our site in Mexico. This makes us very efficient in freighter conversions. Medium and small operators have found that this market is good for them, although leasing companies are IAI's biggest customers at the moment."

The 767-300BDSF is available with or without winglets. Both these aircraft have a maximum MTOW of 412,000lbs and a maximum zero fuel weight (MZFW) of 309,000lbs. The net structural payload of an aircraft without winglets is 114,560lbs/51 metric tons *(see table, page 56)*. Aircraft without winglets are either passenger aircraft that did not originally have winglets or aircraft with winglets that had them removed during conversion.

The additional weight of the winglets means that the operating empty weight (OEW) between the two types is different.

A BDSF 767-300ER conversion with winglets has an OEW of 183,800lbs, while one without them has an OEW of 180,800. The heavier OEW lowers the gross structural payload from 128,200lbs to 125,200lbs *(see table, page 56)*.

Expressing his own opinion, senior consultant at Cargo Facts, Jacob Netz says: "Winglets can result in a 5% fuel saving for a long flight. The benefit of winglets is seen during cruise, not during take-off or descent."

Flying a two-hour sector gives a short net time in which the winglets are beneficial, so the additional weight penalty of the winglets negates any fuel saving.

Typically, the 767-300ER will use 24 (88-inch X 125-inch) main-deck pallet positions or unit load devices (ULDs) and 30 lower-deck (LD-2) positions. This gives the aircraft a total usable volume of 15,364 cubic feet (cu ft). *(see table, page 56)*.

The aircraft is installed with a manual cargo loading system (CLS). "Adding extra weight to a freighter is always an issue," says Matalon. "A heavy CLS means the aircraft can carry less net payload. We install one CLS on the upper deck and save weight by not installing one in the belly."

Bedek can work with any CLS provider of a customer's choosing. "Commonality is important, so it depends on the operator and which system they would like to use in their fleet," says Matalon.

To reduce the aircraft's weight further, Bedek is developing an STC for the -300ER that implements a 9G net instead of a ridged barrier. Replacing the ridged barrier with a net will, however, also sacrifice a main-deck pallet position.

The 767-300BDSF has a maximum packing density of 6.9lbs/cu.ft or 7.1lbs/cu.ft, depending on winglet option *(see table, page 56)*.

Bedek does a lot of the work for the engines at IAI's engine shop. "With one agreement we can manage the entire conversion from start to finish," says Matalon. "The customer will only know IAI as the point of contact. We take full responsibility for maintenance and the conversion. Since we do all the maintenance work during the conversion, this saves time and cost."

IAI has an agreement with Boeing that aircraft converted to freighter by IAI will receive full technical support for the entire aircraft from Boeing.

767-300BCF

Boeing has completed a total of 33 767-300BCF conversions since the type's launch in 2008. *(see table, page 56)*. According to director of Boeing converted freighters and complex modifications, Alvey Pratt: "The Boeing Converted Freighter (BCF) is ideally suited for the growing express-cargo markets, where about 80% of in-service medium widebody freighters operate."

Demand for the BCF remains strong. "There are about 330 767-300ER feedstock candidates that are ideal for conversion," says Pratt. "Boeing forecasts demand for more than 500 widebody freighter conversions in the next 20 years."

The 767-300BCF without winglets, and operating at total tare weight of 17,640lbs, has a net structural payload of 109,840lbs *(see table, page 56)*.

The 767-300BCF has a maximum packing density of 7.0lbs/cu.ft. The winglet-equipped 767-300WBCF has a maximum packing density of 6.8lbs/cu.ft depending on winglet option *(see table, page 56)*.

Because the BCF is an original equipment manufacturer (OEM) solution, BCF customers have full access to Boeing customer support and integrated technical manuals to simplify maintenance and engineering (M&E).

The catalogue list price for a 767-300BCF conversion is $15 million. "However, customer options and the number of conversions can affect the price," says Pratt. "It is estimated that on-ramp costs can vary due to feedstock variability, such as what engine maintenance is required."

For customers with fleet-mixes, Boeing can provide a variety of avionics solutions that can be integrated into the BCF to meet operating requirements.

767-300ER & A330-200/-300 FREIGHTER SPECIFICATIONS

	767-300BDSF	767-300BDSF winglets	767-300BCF	767-300BCF winglets	A330 -200P2F MAX WV	A300 -300P2F MAX WV
MTOW-lbs	412,000	412,000	412,000	412,000	513,677	513,677
MZFW-lbs	309,000	309,000	309,000	309,000	374,785	385,808
OEW-lbs	180,800	183,800	181,520	185,720	242,485	251,308
Gross payload-lbs	128,200	125,200	127,480	123,280	132,300	134,500
Gross payload-tons	57	56	57	55	59	60
Net structural payload - lbs	110,560	107,560	109,840	105,640	114,560	113,312
Net payload-tons	49	48	49	47	51	51
Max packing density-lbs/cu ft	7.1	6.9	7.0	6.8	7.2	6.1
Volumetric payload 6.5lbs/cu ft	101,621	101,621	101,621	101,621	104,104	113,312
Volumetric payload 7.5lbs/cu ft	110,560	107,560	109,840	105,640	116,809	113,312

767-300ER PASSENGER-TO-FREIGHTER CONVERSIONS 2011 TO 2018

Year	2011	2012	2013	2014	2015	2016	2017	2018
Boeing 767-300BCF			1	4	2	3	6	10
IAI 767-300BDSF	4	3	1	1	5	12	17	17
Total	**4**	**3**	**2**	**5**	**7**	**15**	**23**	**27**

Both the Boeing 757 and 767 share a common pilot type rating. Pilots flying for operators that use both types will be able to simply transition between aircraft.

According to Boeing, all but seven of the first 767-300ERs can be upgraded to its highest MTOW of 412,000lbs and MZFW of 309,000lbs.

The first seven aircraft have structural differences that prevent them from reaching these figures. These can be identified by their block numbers: VL001-VL006 and VL011.

The 767-300ER's landing gear may require modification before the HGW limit can be approved.

EFW

EFW offers A330-200 and A330-300 conversion programmes. P2F is the nomenclature for EFW's A330 P-to-F aircraft.

Before the launch of EFW's P2F series, the only other cargo derivative of the A330 was the factory-built A330-200F. Manufactured by Airbus and launched in 2010, a new A330-200F had a list price of $241.7 million. There are 38 in service.

The on-ramp cost for an EFW A330-300P2F is estimated at $42 million; this is $24 million for a feedstock -300 and $18 million for the conversion. Thanks to EFW's close relationship with Airbus, the P2F conversion is likened to an OEM solution.

Located in Dresden, EFW is the exclusive provider of A330-300 conversions to DHL. The US-founded German company currently has contracts for four conversion slots with EFW, and the option to increase the number to 10.

EFW has converted three A330-300s for DHL and three A330-200s for Egyptair.

It is forecasted that an A330-300P2F will have a useful service life greater than 25 years, because of the strength of the market and the aircraft's age and next generation performance.

The A330-300 has more volumetric capacity than an A330-200. This means the A330-300 is more suited to express freight operations, that is volume based.

According to EFW vice president, sales and marketing for Airbus freighter conversion, Wolfgang Schmid, "If you are buying an aircraft for this category with the aim of operating it for more than 15 years, the -300 makes more sense. The -300's greater volume is a huge advantage. Also the difference in price between airframes will be a small percentage of the operation and conversion cost."

Egyptair is converting part of its ageing A330-200 passenger fleet. "It has a slightly different operation to the integrators," says Schmid. "It generally flies higher packing densities on longer flight sectors. This suits the A330-200 better."

Feedstock-certified aircraft with the maximum weight variant, permit the A330-300P2F and the A330-200P2F to have a MTOW of 513,677lbs *(see table, this page)*.

A330-200F

The A330-200 has an MZFW of 374,785 and an OEW of 242,485lbs. This gives the A330-200 a gross payload of 132,300lbs/59 tons *(see table, this page)*.

Loading the aircraft with 22 containers on the upper deck and 13 on the lower deck adds a total tare weight of 17,740lbs. Therefore the A330-200 has a net structural payload of 114,560lbs.

Volumetric capacity for the upper and lower cargo holds equals 16,016 cu.ft, this gives the aircraft a max packing density of 7.2lbs/cu.ft.

Typically, the express freight market operates at a max packing density of approximately 6.5lbs. At this packing density the A330-200 can carry a 104,104lbs of cargo *(see table, this page)*.

A330-300P2F

The A330-300 has a MZFW of 385,808lbs and an OEW of 251,308lbs, this gives the A330-300 a gross payload of 242,485lbs/60 tons *(see table, this page)*.

As the -300 series has a longer fuselage than the -200, it is able to carry more containers. Carrying 26 containers on the upper deck and 15 on the lower deck adds a total tare weight 21,188lbs to the aircraft. This means the aircraft has a net structural payload of 113,312lbs.

Combining an upper-deck volume of 14,220 cu.ft and a lower-deck volume of 4,800 cu.ft gives the -300 a volumetric capacity of 18,581 cu.ft *(see table, this page)*. This permits the aircraft a 6.1lbs/cu.ft maximum packing density, at which the A330-300P2F bulks out at its net structural payload of 113,312lbs; this is 11,691lbs greater than a 767 at the same packing density.

Maintenance-planning for existing aircraft owners that want to convert its ageing fleet is simplified. "This makes the process so much easier than buying a used aircraft with an unknown maintenance history," says Schmid. "Sometimes when you open up an aircraft there will be unexpected issues that require attention."

A standard feature on both the -200P2F and -300P2F is a powered Ancra CLS that has been developed especially for the EFW conversion programme.

On the ground the aircraft has a nose-down attitude, so it needs a powered loading system to allow cargo to travel up and down the gradient safely. Automating the system speeds up the loading procedure and prevents tail-tipping the aircraft.

Separating the main cargo deck and the cockpit is a netted 9G barrier. Using a net is lighter than a ridged barrier and less affects the CofG of the aircraft.

Airbus aircraft typically have standardised cockpits. By definition the fly-by-wire aircraft uses the same software as the Airbus freighter to improve the handling of the aircraft.

Weight variants

For a freighter to optimise its cargo-carrying ability, it is important to have the highest possible MTOW and MZFW.

Different weight variants allow the manufacturer to fine-tune an aircraft's design to best suit its mission. A high MTOW will give the aircraft a longer range or higher payload.

Passenger-configured A330-300s can be split into early-production low gross weight (LGW) and later-built high gross weight (HGW) aircraft.

The earliest passenger A330-300 LGW aircraft were built in 1992-1995, and are identifiable by line numbers (L/N) 012 to 112. The highest achievable weights for these aircraft are an MTOW up to 460,766lbs, and an MZFW up to 379,195lbs. It is not possible to upgrade the weight limits further to an acceptable level on this subsection of aircraft.

Other early passenger LGW aircraft were manufactured up to 1998, from L/N 113 to 244. Possessing a slightly higher weight certification, these aircraft can achieve an MTOW of 480,608lbs, and an MZFW of 379,195lbs. It is possible to increase the weight of these aircraft to an adequate level.

A330-300s produced from L/N 256, built in 1999 and beyond are defined as HGW. These passenger aircraft can be certified to an MTOW of 513,677lbs and reach an MZFW of 385,808lbs.

An MTOW option of 518,086lbs was introduced from L/N 1,276 in 2012. It is possible to upgrade passenger aircraft built from 2004 to this level, but the modification reduces MZFW to 318,400lbs. This in turn will reduce payload.

Airbus recently introduced a newer weight variant (WV) that increases MTOW to 524,700lbs and 533,519lbs. Yet the availability and high feedstock price for this newer type will negate the benefit of the extra payload.

"The max weight variant is a very important option when converting an A330-300, because it is a really big aircraft and operators do not want to be limited to a lower payload," says Schmid.

The maximum weight variant is needed to extract a maximum 60 tons gross payload from feedstock aircraft. EFW's upgrade programme enables the aircraft to be raised to the highest weight variant.

"Sometimes the modification only requires a simple paperwork change, although some changes do require structural work," says Schmid. "We can do all the work, but the workscope in the service bulletin (SB) is agreed by Airbus."

The customer will have to apply to Airbus for the correct SB. EFW will then incorporate the workscopes for the modifications during the conversion process. An example of this work could be upgrading of the brakes or simply changing the air pressure within the tyres.

"The good news is that there is an upgrade programme available, and the cost

Aircraft with the highest MTOW are prime candidates for conversion. Currently leasing 20 aircraft is retail giant Amazon.

can be discussed," says Schmid.

It is possible to buy and convert a lower WV aircraft to reduce operating costs. However operators like the flexibility of the higher WV, because they may want to carry a heavier cargo and not be limited.

Feedstock criteria

The better candidates for freighter conversion will have several characteristics. First, aircraft will be in the zone of convertibility when they are 15-20 years old. More specifically, the total accumulated FC will provide a better indicator of an aircraft's potential. Freight carriers will want to operate a converted aircraft for at least 10 years, and possibly as many as 15-20. Most will have annual utililsations of 600-900FC, depending on style of operation and average route length and flight time. Aircraft can therefore be expected to amass 6,000-9,000FC in a 10-year period. Ideally the total number of FC already accumulated at time of conversion, and those that could potentially be added during subsequent freighter service will not be enough for the aircraft to reach the threshold for a large maintenance requirement, such as ageing aircraft inspections or a structural AD. Most 767-300ERs have operated at 5.0-7.0FH per FC, and so accumulated no more than 15,000FC by retirement at 15-20 years of age by their primary operators.

Engine choice is an important consideration. The 767-300ER fleet is divided between aircraft equipped with CF6-80C2, PW4000-94 and RB211-524H engines. Aircraft with RB211-524H engines are unlikely freighter conversion candidates because of their scarcity, high OEW and lack of non-OEM support for engine maintenance.

The CF6-80C2 and PW4000-94 equip the majority of the 767-300ER fleet. Moreover, the two engines were also used on four other widebody types; including the 747-400, MD-11, and A300-600R.

Using a quick engine change kit (QEC) via an SB is a simpler alternative and makes it possible to substitute CF6-80C2 engines from A300-600/A310 and MD-11 aircraft. For example, SB 72-1470 covers swapping an MD-11 engine to a 767-300ER.

Large numbers of these have been retired. This can result in large numbers of time-continued engines being available, making it possible for freight carriers to avoid the expense of large engine maintenance events.

The situation is different for the A330-200/-300. These are exclusively powered by the Rolls-Royce Trent 700, GE CF6-80E1, and PW4000-100. First, most are powered by the Trent 700. The lack of independent maintenance providers for the Trent 700 means that freight operators are likely to have to pay relatively high maintenance costs for the engines over the long term. There are independent shops for the CF6-80E1 and PW4000-100, but these are limited in number.

Freight carriers and lessors will also look for aircraft with the same specification and configuration. It is ideal for candidates to have a good pedigree. "Generally buyers do not want to take aircraft that have been with two or three operators," says Fortune. "Such aircraft may not have been maintained properly, which can mean more money needs to be spent on them."

It makes sense to source multiple aircraft from the same operator, because sisterships are usually fitted out to a uniform specification, component configuration, and airworthiness directive (AD) and service bulletin (SB) status. The inherent commonality saves a buyer from re-investing in expensive avionics and equipment during the conversion phase.

Standardised aircraft that have the same make and model of engine and systems will reduce maintenance costs, lower spare part inventory and lessen the need for additional personnel type ratings.

Conversion candidates: 767

There are 360 767-300ERs in active passenger aircraft fleet equipped as follows: 222 with different variants of the CF6-80C2; 134 with different variants of the PW4000-94; 11 with PW4052s; one with a PW4056; 95 with PW4060s; 26 with PW4062s; and five with RB211-524Hs.

Age and accumulated FC are of particular importance for 767-300ER candidates. This relates to an ageing structural AD that affects the aircraft.

Recently several airworthiness directives (AD) have been issued against the 767 for monitoring widespread fatigue damage (WFD) on the aircraft. WFD can lead to terminating actions being required to large sections of the airframe.

Introduced in February 2017, AD 2016-25-07 requires the replacement of the aft pressure bulkhead at Station 1582 of Section 48 of the fuselage with a new improved one. This has to be done with all applicable related investigative and corrective actions.

Compliance time for the action is before the accumulation of 60,000FC, or within 36 months of the effective date of this AD, whichever occurs later, but no earlier than 37,500 total accumulated flight cycles.

According to the Federal Aviation Administration the part cost is $646,899. Labour costs are estimated to be $130,985 for 1,541 man-hours.

"We can clear any SB or AD," says Matalon. "On each aircraft conversion we can resolve any maintenance issue on behalf of the customer."

Of the CF6-80C2-powered aircraft, 24 are in service with American Airlines. With an average FH:FC ratio of 6.0, these have been used on a long-haul network. The oldest aircraft in the fleet is 26 years old, and the youngest 16 years old.

In 2018 Bedek completed 17 767-300ER conversions. Its biggest customers are large lessors.

Of the American Airlines fleet, 16 aircraft were built from 1998 to 2003 and have accumulated 57,861-102,273FH and 9,321–12,786FC. As most of this fleet is 15-20 years old, it is ideal for conversion.

It is reported that because of the 'good quality' of American Airlines' feedstock, The Air Transport Services Group (ATSG), has agreed with Jetran to buy 20 of these aircraft over the next three years.

ATSG is planning to convert six in 2019, nine in 2020 and five in 2021.

CF6-80C2-powered fleet

The remaining in-service passenger-configured fleets of CF6-80C2-equipped aircraft are examined. Important criteria are fleet size and age, accumulated FH and FC, and engine variant. The operator's future fleet plans are also influential.

The biggest CF6-80C2-powered fleets are operated by ANA (24), JAL (28), LATAM Group (33), Delta Airlines (23), and Air Canada/Air Canada Rouge (19). These total 126 units.

Delta Airlines operates three CF6-80C2-powered aircraft that are 30 years old and have accumulated 21,403-22,202FC. Delta Airlines has a history of using the maximum amount of maintenance life from the airframe and engines. It can be assumed that these 767-300ERs will have little green time left when they are released on to the market.

Three young fleets that are operating CF6-80C2F-powered aircraft are Japan Airlines (JAL), All Nippon Airways (ANA) and the LATAM Group.

The ANA fleet of 24 aircraft is seven to 21 years old. Of these, 10 are 15-20 years old, and have accumulated 7,926-13,791FH and 2,200-3,947FC. The average FH:FC ratio is 3.0, so these aircraft will have been used on Japanese domestic and intra-Asia Pacific routes.

ANA has ordered 13 787-9s and one 787-10, to be delivered in 2019-2021. It is possible these new aircraft will signal the retirement of some of ANA's 767-300ERs.

JAL's fleet totals 28 aircraft, including 11 built in 2002-2006, and 17 in 2007-2011. The older aircraft have accumulated 4,505-18,958FH and 1,332-5985FC. The average FH:FC ratio is 3.0.

JAL is taking deliveries of seven new 787s and 30 new A350s by 2020 and 2023 respectively. It is expected that these acquisitions will trigger the sale of the older batch of 767-300ERs.

The LATAM Group's 33 aircraft mainly operate out of Brazil and the surrounding areas. They fly average sectors of 5.3-6.7FH, so they have a good FH:FC ratio. Two aircraft were manufactured in 1998 and have completed 67,739FH and 84,532FH. The remaining fleet dates from 2006 to 2012.

Recently LATAM Cargo took redelivery of a 767-300BCF and three factory-built 767Fs.

LATAM's freight operation means it is possible that the best candidates from the airline will be handed to LATAM Cargo to convert. Yet because LATAM Airlines has a large fleet of 767s, it is likely that many of its aircraft will reach the open market.

In addition to the three CMC, CF6 aircraft, Delta Airlines operates 23 CF6 FADEC-equipped aircraft. These aircraft were built in 1991-2001. Of these, 21 were built in 1998-2001 and have completed 74,537-80,329FH and 9,617-18,123FC; 12 aircraft built from 1999 to 2001 have a FH:FC ratio of about 7.8 hours.

Condor operates seven units. The oldest was built in 1994 and has accumulated 16,355FC with a FH:FC ratio of 6.0. The youngest aircraft in the German fleet is 18 years old and has amassed 80,971FH and 10,924FC with a FH:FC ratio of 7.65.

Icelandair and TUI UK both operate four aircraft built in 1997-2000. Icelandair's aircraft have an FH:FC ratio of 5.3 and TUI UK's 5.2. Icelandair's aircraft have accumulated 71,029-98,688FH and 13,903-18,043FC, while TUI UK's have 83,281-90,995FH and 14,211-17,675FC.

TUI, is expecting to take delivery of two 787-9s in 2019 and 2021.

PW4000-94-powered fleet

Four PW4000-94 series sub-variants are available to power the 767-300ER. The last two digits in the engines' nomenclature relate to the maximum thrust rating each variant can provide. The PW4052 can provide 52,000 lbs of thrust, and is the lowest-rated variant of the PW 767-300ER engines.

The PW4062 has a thrust rating of 62,000 lbs. of thrust, and is the highest-rated variant of the PW series of engines available for the 767-300ER.

There are a total of 133 PW4000-94-powered aircraft in the fleet. The largest fleets are operated by United (35), Delta Airlines (30), and Air Canada Rouge (12).

United Airlines has 11 aircraft with PW4052 engines, built in 1998-2000. They have accumulated 65,770-74,368FH and 14,054-16,900FC. Their FH:FC ratio is 4.5.

United Airlines has 18 787s on order that will be delivered in 2019-2020.

Euro Atlantic Airways operates a PW4056-powered 767-300ER built in 2002. It has accumulated 56,211FH and 17,729FC with an FH:FC ratio of 3.17 hours.

With a fleet of 95 aircraft, the PW4060 is the most numerous sub-variant of the PW4000 in the 767-300ER fleet.

Delta Air Lines operates 30 PW4060-equipped aircraft. Built in 1990-1998, they have accumulated 92,859-130508FH and 13,272-18,627FC. They have the highest accumulation of FH and FC in the PW4060 fleet. The FH:FC ratio is 6.9.

Delta Air Lines has 12 A350s on order that are due to be delivered in 2025-2026.

United Airlines operates 24 aircraft. Of these, 21 were built in 1991-1993,

ATSG is one of the worlds largest lessors of converted 767 aircraft, and has recently announced that it will acquire 20 767-300ERs from American Airlines.

accumulating 105,479-114,291FH and 16,413-17,640FC. FH:FC ratio is 6.4.

United operates three younger aircraft built in 2000-2001. They have accumulated 64,564-67,970FH and 13,304-14,433FC; an FH:FC ratio of 4.9.

In 2017, United Airlines began upgrading 14 PW4060-powered 767-300ERs with state-of-the-art business-focused interiors. The high cost of this interior upgrade makes it unlikely that United will put these aircraft on the market anytime soon.

Air Canada Rouge operates 10 PW4060-powered aircraft. The oldest of these aircraft is 26 years old and has amassed 107,097FH and 19,790FC. The youngest of these aircraft was built in 2003, and has 58,681FH and 11,125FC.

Condor operates seven aircraft and Austrian six. Condor's fleet was built in 1991-1994 and has completed 117,161-129,746FH and 16,720-19,273FC. Built in 1991-2000, the average age of Austrian's fleet is lower than Condor's. The Austrian aircraft have completed 86,732-128,365FH and 11,125-19,158FC. Both Condor and Austrian aircraft have an average FH:FC ratio of about 7.0.

El Al operates three aircraft. The two youngest aircraft in the fleet are 19 and 21 years old. They have completed 31,189-50,888FH and 7,115-8415FC; the average FH:FC ratio is 5.2. El Al is completing delivery of their 787 fleet of 16 aircraft.

PW4062-powered aircraft account for 26 units in the 767-300ER fleet. The oldest aircraft was built in 1991 and the newest in 2013. These could be highly desirable conversion candidates. Of this fleet, 18 are 15-28 years old, including two Air Canada Rouge units and two Condor units.

Ethiopian Airlines operates six PW4062s built in 2000-2005. These have 56,406-75,864FH and 13,719-18,825FC; with an FH:FC ratio of 4.0.

Ethiopian Airlines has 12 A350s on order that will be fulfilled by 2022.

Conversion candidates: A330

The A330 fleet comprises 1,179 passenger aircraft in service, split between 524 A330-200s, and 655 A330-300s.

The A330-200 fleet is further divided between 150 CF6-80E1-powered aircraft, 86 PW4000-100-powered aircraft, and 288 Trent 772-powered aircraft.

The A330-300 fleet includes 122 CF6-powered aircraft, 88 PW4000-100-powered aircraft, and 445 Trent 768/772-equipped aircraft. Entering service in 1998, the shorter A330-200 is younger than the A330-300 that entered service in 1994. Both main series are still in production.

The main A330-300 fleets that could potentially provide conversion candidates are analysed.

Of the A330-300 CF6-80E1-powered fleet, the oldest aircraft are three Qantas units that are 16 years old.

Qantas operates 10 CF6-powered aircraft that were built in 2003-2005. These aircraft have completed 58,263-66,252FH and 8,283-10,168FC with an FH:FC ratio averaging 6.9. Qantas has six 787s on order that are scheduled to be delivered in 2019-2020.

China Airlines operates 24 CF6-powered aircraft, of which 12 were built in 2004-2006. These have accumulated 38,384-44,113FH and 13,525-18,901FC with a FH:FC ratio of 2.4.

Qatar Airways operates three aircraft built in 2005 and four built in 2006. These aircraft have accumulated 59,053-64,658FH and 11,954-13,078FC at an average FH:FC ratio of 5.2. It has orders for 30 787s and 34 A350s that will be completed by 2022.

Other CF6 A330-300 operators include Aer Lingus (9), Delta (9), EVA Air (9), Finnair (8) and Iberia (8). Turkish Airlines operates 20 aircraft that entered service in 2013-2016.

The PW4000-10 has two main variants: the PW4168 rated at 68,000lbs and the PW4170 rated at 70,000lbs. The PW4168/70-equipped fleet has 19 aircraft that are older than 15 years. Comprising aircraft built in 1994-2004, this subsection of the fleet includes Delta (8), Korean Air (6) and Brussels Airline (2). Other aircraft of this vintage are operated in small fleets.

Delta's A330-300 fleet in the PW4168 category have accumulated 65,552-68,085FH and 8,555-8922FC; an FH:FC ratio of 4.5 hours. The youngest aircraft is 16 years old. Delta has 10 more aircraft in this category that were built in 2006-2007.

PW4000-100-powered Korean Air candidates over 15 years old have accumulated 68,358-70,080FH and 22,827-28,312 with an FH:FC ratio of 3.6.

Korean Air has 30 orders for 787s that will be delivered in 2021-2024.

Malaysia Airlines operates 10 PW4170-powered aircraft, built in 2011-2014. China Southern operates 16 aircraft built in 2013-2017.

Asiana Airlines has 15 aircraft built in 2004-2013. The oldest aircraft has accumulated 57,459FH and 18,753FC, with an FH:FC ratio of 3.0. Asiana has 21 A350s on order for 2019-2024.

The Trent 700 series engines powers 67% of the A330-300 fleet. Most of these were built after 2008, so are relatively new, but there are 28 Trent-powered aircraft older than 15 years. These are operated by Cathay Dragon (10), Cathay Pacific (3), Lufthansa (7), Garuda Indonesia (6) and Air Transat (2).

Most Trent-powered A330-300s are less than 10 years old and operated in medium and large fleets. These include: Aeroflot (17), Air China (29), Air Asia X (20), Cathay Pacific (18), China Eastern (17), China Southern (10), Garuda Indonesia (17), Hainan Airlines (22), Hong Kong Airlines (10), Philippine Airlines (15), Saudi (32), Singapore (18), Swiss (14), Thai Air Asia X (10), Thai Airways International (15), Turkish Airlines (17) and Virgin Atlantic Airways (10). AC